NHTSA Phoenix Tire Dataset Version 4.1

Updates:

- Version 1.0
  - Original dataset containing Type B tire data only (one of the six tire models in the study)

- Version 1.1 - Revisions
  - Tensile wedge table: Typographical errors corrected.
  - Lists of corresponding pre & post-test photos, indentation modulus reports, & shearography reports added to tables. To obtain a CD-ROM containing these individual files, send a request to the contact person listed at the end of this document.

- Version 1.2 - Revisions
  - Indentation modulus: Bead area table added, shoulder area table reformatted

- Version 1.3 - Revisions
  - Indentation modulus: Shoulder area table – "Tread Base" columns added
  - Index: Notes on mileage estimates added

- Version 1.4 - Revisions
  - Total Crosslink Density, Long Form – New data added / typographical errors corrected
  - Pre-test Inspection – More tread depth data added
  - Fixed Oxygen – All new, worksheet added
  - Crosslink Density Distribution – All new, worksheet added
  - All worksheets reformatted to display significant figures

- Version 2.0 - Revisions
  - Data for two additional tire models added
  - Fixed oxygen – Skim rubber retested for tire 0067
  - Dynamic Mechanical Testing (DMA) – All new, worksheet added
  - Microscopy – All new, worksheet added
  - Micro Dematttia – All new, worksheet added
  - Two-ply laminate fatigue – All new, worksheet added
  - Crosslink Density Distribution – Additional skim rubber data added for the Type B tire.
  - Note: Data for confirmed, zero-mileage full-size spare tires is included for the two additional tire models. **Users of the data should be cautioned to not accidentally include full-size spare tire data in analysis of on-road tires. Analyze spares separately.**

- Version 2.1 – Revisions
  - Fixed oxygen data updated
  - Two-ply laminate fatigue data updated
  - Indentation modulus data, bead region updated

- Version 3.0 – Revisions
  - Data for three additional tire models added
  - Fixed oxygen data updated
  - Microscopy updated
  - Two-ply laminate fatigue data updated
  - Indentation modulus data, bead region updated

- Version 3.1 – Revisions
  - Fixed lingering data format problems with data transferred from MS Access to MS Excel. Completely new Excel file.

- Version 4.0 – Revisions
  - Material properties data for additional tires added, resulting in additional data points on many tables
  - DOT midweek date/age of tire 0127 was 2000 but should have been 1999. Tire age had been corrected from 2.49 to 3.49 years old.
  - Invoice dates added. (Since tests are ordered by tire ID number, often a test is not invoiced for until all tests or replicate tests on that tire are complete. Therefore the invoice date does not correspond to the date of the test.)
  - Fixed typo in Stepped-Up Speed table: N0317_SUS2.jpg in Photo2 column
  - Updated removal condition notes in Stepped-Up-Speed (SUS) table for tires 0014, 0070, 0156, 0170, 0317, 0319.
  - Fixed typo in Stepped-Up Load table: Tire 0041 = OE in ORN column
  - New indentation modulus data, bead and shoulder regions, added
  - New high-speed peel strength and 100C peel strength data tables added
  - Tires 0201 & 0223 were misidentified as OE tires on a 2001 Chevy Venture minivan. Actual retrieval sheet information list these tires as replacement tires collected off of a 2001 Chevy Express Van 3500. This van was registered as a commercial transport vehicle.
  - The DOT Code for tire 0223 was corrected, the actual age of the tire is 2.54 yrs.

- Version 4.1 – Revisions
  - A new column titled “Phase” added to each tab. Phase refers to that phase of the project (Phase I - IV) that contained this test. All Phoenix-retrieved tires were tested during Phase I.

- More sidewall information added to tire model descriptions. UTQGS treadwear values varied during the span of production for some tire models and were difficult to track.
- Third digit of DOT code for tires Barcode 0306, 0307, 0308, 0305, 0313 was corrected from a "V" to a "U".
- Monthly static inflation pressure loss rates at 21° and 70°C added for the six tire models (worksheets "IPR 21C" & "IPR 70C").
- The results of a NHTSA funded study of belt-coat crosslink evolution by Dr. Edward Terrill of the Akron Rubber Development Laboratory, Inc. has determined that the solvent swelling technique used to determine crosslink density distribution measures both sulfur and oxygenated bonds simultaneously and cannot be interpreted as measures of "S1", "S2", and "S8" sulfur bonds alone. New names for the variables are being developed.
- Tires 1238, 1239, 1240, and 1241 were listed as having no cap plies in prior microscopy datasets. These tires in fact have double full length nylon overlays. The microscopy dataset has been updated.

Notes on Dataset Version 4.1:

1. Dataset Version 4.1 contains the results for the Type B, C, D, E, H, & L tires. Subsequent datasets will include additional data on this and the three other tire brands as the data become available.

Tire	Size	Load Index	Speed Rating	Brand	Model	OE Vehicle	OE Model
B	P195/65R15	89	S	BFGoodrich	Touring T/A	Chevy	Cavalier
C	P205/65R15	92	V	Goodyear	Eagle GA	Lexus	ES300
D	P235/75R15	108	S	Michelin	LTX M/S	Ford Dodge	E 150 Van Ram Van 1500
E	P265/75R16	114	S	Firestone	Wilderness AT	Chevy/GMC	Silverado/Tahoe Sierra/Yukon
H	LT245/75R16/E	120/116	Q	Pathfinder[1]	ATR A/S OWL	NA*	NA*
L	255/65R16	109	H	General	Grabber ST A/S	Mercedes	ML320

*Replacement market light truck tire (Discount Tire house brand / Manufactured by Kelly Springfield)

2. Data included in this version:
   a. Crosslink density distribution, long form equation – Skim, wedge, & tread
   b. Dynamic mechanical testing (DMA) – Wedge
   c. Fixed oxygen data – Skim & wedge
   d. Indentation modulus ("Modulus profiling") – Shoulder & bead

[1] Kelly-Springfield is the manufacturer of the Pathfinder tire.

e. Micro Demattia – Wedge
f. Microscopy – Tire cross-section
g. Peel strength – Skim & wedge
h. High-speed peel strength – Skim & wedge
i. 100°C peel strength – Skim & wedge
j. Pre & post-test inspection data
k. Shearography – Bead-to-bead separation
l. Shore A / Durometer hardness – Innerliner, skim, wedge & tread
m. Stepped-Up Load to failure test ("SUL") results
n. Stepped-Up Speed to failure test ("SUS") results
o. Tensile properties – Skim & wedge
p. Tire information index & photos pretest
q. Total crosslink density, long form equation – Skim, wedge, & tread
r. Two-ply laminate fatigue
s. Monthly static inflation pressure loss rates at 21 and 70C

3. Omission: The data for tires that were confirmed as not spending their entire service lives in Arizona have been omitted (i.e. 20,000 miles in Wisconsin & 5,000 miles in Arizona due to owner relocation or vehicle sale/trade-in). Non-Arizona tires were observed to have markedly different aged properties than Arizona-only tires and thus would confound the Phoenix datasets if included.

4. **"DOT_Est_Mileage" is 0 miles for new tires, actual vehicle odometer mileage for OEM tires, and estimated for replacement tires. Estimated mileage for replacement tires = Tire DOT Age * (Vehicle Odometer Mileage / Vehicle Age).**

5. These datasets will be updated frequently as additional data is processed and becomes available.

6. Details of the Stepped-Up Load to failure test ("SUL")

    a. SUL Specs (referred to as "END_AIR" internally)
        1. Temperature: 38° ±3°C
        2. Inflation mixture: Air
        3. Speed: 120 km/h (75 mph)
        4. Duration: To failure
        5. Inflation pressure: 139 Endurance Test pressure

Table 1: SUL Test Parameters

Test Stage	*Duration (hours)*	*Load as a percentage of tire maximum load rating*	
1	*4*	*85%*	*139*
2	*6*	*90%*	
3	*24*	*100%*	
Inspection	***1***	*****	*****
4	*4*	*110%*	*Until Failure*
5	*4*	*120%*	
Etc.	*4*	*Increment load by +10% every 4 hours until failure*	

b. Mount each test tire per Item 3[2] (dry atmospheric air). Refer to the FMVSS 139 Endurance test for the appropriate inflation pressure.

c. If testing is not done the same day as the tire is mounted, deflate and reinflate the tire per Item 3 inflation specifications the day roadwheel testing is to commence.

d. Condition the tire-wheel assembly at 38° ±3°C for not less than three hours prior to testing.

e. Readjust the tire pressure to the value specified in the 139 Endurance test immediately before testing.

f. Conduct the FMVSS 139 Endurance test portion of the SUL test until completion or failure with string limits set 2.0" ± 0.5" from the surface of the tire.

g. After completion of the 139 Endurance portion, conduct the specified one-hour cool-down period. During the cool-down period, allow at least 15 minutes after the test is completed before entering the roadwheel enclosure. If safe, and the tire is still inflated, measure and record the tire pressure. Conduct a visual inspection of the tire in the 38°C lab environment.

h. Normal failure conditions for the FMVSS 139 Endurance test such as minor chunking, cracking, etc. are noted, but do not qualify as a removal condition for the remaining portion of this test. Air-outs, tread separations, sidewall blowouts, belt separations, large chunking, etc. are valid "catastrophic failure" removal conditions. If visual evidence of a catastrophic failure or air-out is found at the inspection, deflate and unmount the tire and conduct a post-test tire inspection per Item 11. Include the time and the equivalent mileage at which the failure occurred in Item 11 report, and then take the three Item 11 specified photographs

[2] "Items" refer to piecewise services pre-defined by NHTSA's testing contract. For instance, "Item 3" contains detailed specifications for one unit of mounting a tire on a wheel with air inflation at pre-defined costs.

(photos are taken and charged per Item 12). The test is terminated upon evidence of a valid removal condition.

i. If no removal condition is detected from the visual inspection, continue the remaining portion of the SUL test. Resume testing at according to the "Test Stage 4" parameters in Table 3.5 below. Continue to increase the load +10% every 4-hours as indicated in "Test Stage X", Table 1 until said failure or air-out occurs.

j. After a removal condition is detected: Allow at least 15 minutes after the test is completed before entering the roadwheel enclosure. If safe, and the tire is still inflated, measure and record the final tire pressure within 1 hour of the end of the test. Deflate and unmount the tire and then conduct the post-test tire inspection per Item 11. Include the time and the equivalent mileage at which the failure occurred in Item 11 report, then take the three Item 11 specified photographs (photos are taken and charged per Item 12).

7. Details of Stepped-Up Speed to failure test ("SUS")

SUS Specs (referred to as "HS_AIR" internally)

a. Mount each test tire per Item 3 (dry compressed air) and use a new metal valve stem. Tire inflation pressures are per the 139 High Speed test.

b. If testing is not done the same day as the tire is mounted, deflate and reinflate the tire per Item 3 inflation specifications the day roadwheel testing is to commence. Condition the tire-wheel assembly at 38° ±3°C for not less than three hours prior to testing.

c. Before or after mounting the assembly on a test axle, readjust the tire pressure to that specified by 139 High Speed test and record value.

d. Conduct the 139 High Speed test break in procedure.

e. Initiate the 2-hour cool-down period at 38° C. Allow at least 15 minutes after the test is completed before entering the roadwheel enclosure. At the end of the 2-hour cool down, measure and record pressure and readjust inflation pressure to applicable pressure in immediately before the test resumes.

f. Conduct the 139 High Speed test until completion or tire failure with string limits set 2.0" ± 0.5" from the surface of the tire.

g. Post 139 High Speed test, allow tire to cool down for 45 minutes. Complete post-test tire inspection (S6.2.1.2.8) in the 38°C lab environment. If safe, and the tire is still inflated, measure and record the pressure within 1 hour of the end of the test.

h. If visual evidence of failure is found at §8.7 inspection[3], deflate and unmount the tire and then conduct a post-test tire inspection per Item 11. Include the time and the equivalent mileage at which the failure occurred in Item 11 report, then take the three Item 11 specified photographs (photos are taken and charged per Item 12). The test is terminated upon evidence of tire failure.

i. If the tire passes 139 performance requirements at §8.7 inspection: Test continuously and uninterrupted through thirty-minute speed steps as shown in Table 2, starting at Test Stage 4. Speed is increased by +10 km/h in 30 minute increments **until the speed rating of the tire is reached, at which point the test speed is maintained until tire failure.** The inflation pressure is not corrected and the test load is maintained at the value specified by the 139 High Speed test.

Table 2: SUS Test Parameters

Test Stage	Duration (hours)	Speed	
1	0.5	140 km/h	139 HS
2	0.5	150 km/h	
3	0.5	160 km/h[1]	
Inspection	1	*	*
4	0.5	170 km/h	Until failure
5	0.5	180 km/h[2]	
6	0.5	190 km/h	
7	0.5	200 km/h	
8	0.5	210 km/h[3]	
9	0.5	220 km/h	
10	0.5	230 km/h	
11	0.5	240 km/h[4]	

1 Do not increment speed over 160 km/h for Q speed rated tire, hold at speed rating until tire failure.

2 Do not increment speed over 180 km/h for S speed rated tires, hold at speed rating until tire failure.

3 Do not increment speed over 210 km/h for H speed rated tires, hold at speed rating until tire failure.

4 Do not increment speed over 240 km/h for V speed rated tires, hold at speed rating until tire failure.

j. After the failure occurs: Allow at least 15 minutes after the test is completed before entering the roadwheel enclosure. If safe, and the tire is still inflated, measure and record the final pressure within 1 hour of the end of the test. Deflate and unmount the tire and then conduct the post-test tire inspection per Item 11. Include the time and the equivalent mileage at which the failure occurred in Item

[3] Note: Per 139 performance requirements, a tire failed when there is visual evidence of tread, sidewall, ply, cord, inner liner, or bead separation, chunking, broken cords, cracking, or open splices, and the tire pressure is less than the initial test pressure. "Visual evidence" means visible to the unaided eye.

11 report, then take the three Item 11 specified photographs (photos are taken and charged per Item 12).

8. Please direct any technical questions to:

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